The Honorable John C. Coughenour

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

SCOTT AND KATHRYN KASEBURG, ET AL., Plaintiffs, vs. PORT OF SEATTLE, a municipal corporation; PUGET SOUND ENERGY, INC., a Washington for profit corporation; KING COUNTY, a home rule charter county; and CENTRAL PUGET SOUND REGIONAL TRANSIT AUTHORITY Defendants.	)	No. 2:14-CV-000784-JCC DECLARATION OF STEPHEN M. SULLIVAN

I, Stephen M. Sullivan, declare under penalty of perjury under the laws of the State of Washington as follows:

1. I am over eighteen years of age. I have personal knowledge of the facts contained in this declaration and am otherwise competent to testify to the matters in this declaration.

2. I am presently employed as Managing Director of R.L. Banks & Associates, a railroad consulting company founded in 1956. I have over 35 years of experience in field, line,

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and staff operations. I have been engaged as an expert on railroad operations and railroad right-of-way related to the engineering standards for the construction of railroads and the structures required to effect railroad operations. In preparing my report, I have consulted the American Railway Engineering and Maintenance-of-Way Association (AREMA) standards. The AREMA standards are universally adopted and applied across all U.S. railroads. For more than 100 years AREMA and its predecessor organizations have served as the engineering standard bearers for the railroad industry. AREMA's mission, "*The development and advancement of both technical and practical knowledge and recommended practices pertaining to the design, construction and maintenance of railway infrastructure"* identifies the importance and role of the AREMA standards to U.S. railroads.

3. The standard railroad car on today's US railroads can weigh as much as 286,000 pounds (lbs.) and in fact all new railroad cars are built to carry a weight of 286,000 lbs. The AREMA construction and maintenance standards are designed to ensure that railroad track, under regular use and normal condition, can safely support, and efficiently handle, these 286,000 lb. railroad cars.

Railroad Track Construction

4. Railroad track is built on three layers of material. Beginning from the surface and working down, these layers consist of ballast, sub-ballast, and subgrade. *See* Figure 1. The lowest layer is the subgrade and it consists of compacted soil and fill. Sub-ballast is then laid on top of the subgrade. Sub-ballast is typically made of small crushed stones. It gives a solid support for the ballast or top layer, and seals out water from the underlying

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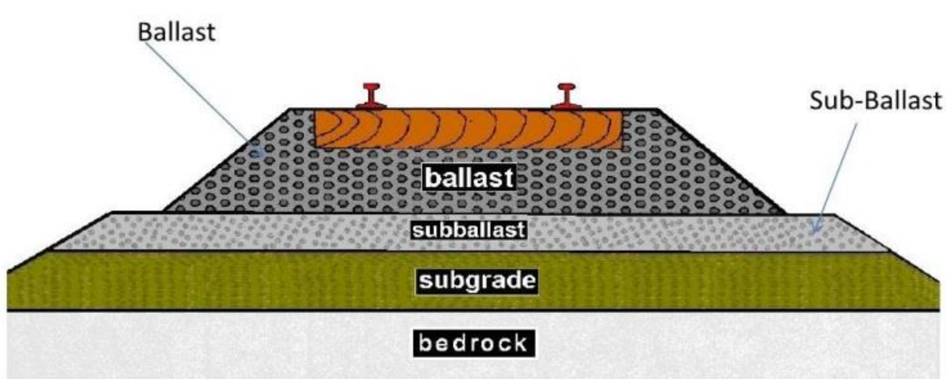
ground. Ballast is permeable, granular material placed under and around the ties to promote track stability. It should be hard, tough, abrasion resistant, and angular. Common types of ballast include crushed granite, basalt, trap-rock and slag. The thickness of a layer of track ballast depends on the size and spacing of the ties, the amount of traffic expected on the line, and various other factors such as climate and soil composition. Railroad ties, the materials used to support and attach the rail, are laid into the layer of ballast. Rail and tie plates are laid on top of the ties, creating the surface the trains use to operate over.

5. For the various layers of material, AREMA standards for main track require a minimum of 24 inches of subgrade, a minimum of 12 inches of sub-ballast, and a minimum of 12 inches of ballast. Passenger and high density rail lines may require ballast up to 20 inches thick. An insufficient depth of ballast overloads the underlying subgrade and in the worst cases, can cause the track to sink, creating unsafe conditions where derailments and accidents can occur.

Figure 1



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6. In addition to track, railroads use their right-of-way corridors to carry electrical and fiber optic lines used for communication, signals, and other functions of railroad operations. Using the AREMA standards, cables, conduit, and pipe used to for these purposes are to be placed, at a minimum, six inches to 10 feet below the subgrade based on underground conditions.

Railroad Gradient

7. Vertical tangents, commonly referred to as grades, are straight lines classified by the change in elevation or incline. The grades, which must be traversed by rail cars and locomotives, are generally much more limiting than those on roads or highways due to the limited amount of friction available at the interface of the steel wheel and the steel rail, as well as the substantially smaller power to weight ratio of rail cars in trains. The grade is measured in the amount of rise or fall over a distance and is expressed in terms of percent. For example, a grade, which rises 1.5 feet in 100 feet traveled, is referred to as a 1.5% grade (travelling in the reverse direction it would be a -1.5% grade). In a perfect world, all railway alignments would be tangent and flat, providing for the most economical operations with the least amount of maintenance and, is the key objective in the construction and maintenance of any length of railroad. With an increase of 1% in grade, or a 1 ft. rise over a 100 ft. distance, the tractive effort, or pulling power of locomotives on a train is reduced by one half. On most rail lines in the U.S. grades are kept under 1%, however there are exceptions, with the biggest grade being 2.2%[1]. Any grade over 1% requires changes in operations, sometimes significantly affecting train

[1]Trains operating in areas with grades up to 1% will add additional tractive force in the form of additional locomotive horsepower to compensate; where grades exceed 1% “helper” locomotives are added and removed from trains to compensate for the loss of tractive force.

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performance and efficiency. As such, when a change in terrain grade or elevation occurs that is greater than 1% and cannot be circumvented then the railroad must find a way through or across the area.

Tunnels, Cuts & Bridges

8. Railroad tunnels and bridges are the engineering solutions for dealing with changes in terrain to maintain appropriate grades. Tunnels are constructed through areas of mountainous and hilly topography. Tunnels can be hundreds of feet below the surface of the ground above. For example, BNSF's Cascade Tunnel located under Stevens Pass, WA is 7.8 miles long and carries the railroad as much as 2900 ft. below the surface of the ground above, with ventilation shafts rising from the tunnel to the surface at various points along the length of the tunnel. *See* Figure 2. Another method used by railroads to deal with hilly topography is open cut engineering where the surface is lowered, or cut away until it meets the railroad right-of-way. Open cuts can be several hundred feet deep and are contingent on a number of factors including soil content, hydrology, amount of material to be removed and climate. The recently completed Pinkerton open cut project (2012) in Pennsylvania, lowered the surface over 200' for a distance of over 1000'. *See* Figure 3.

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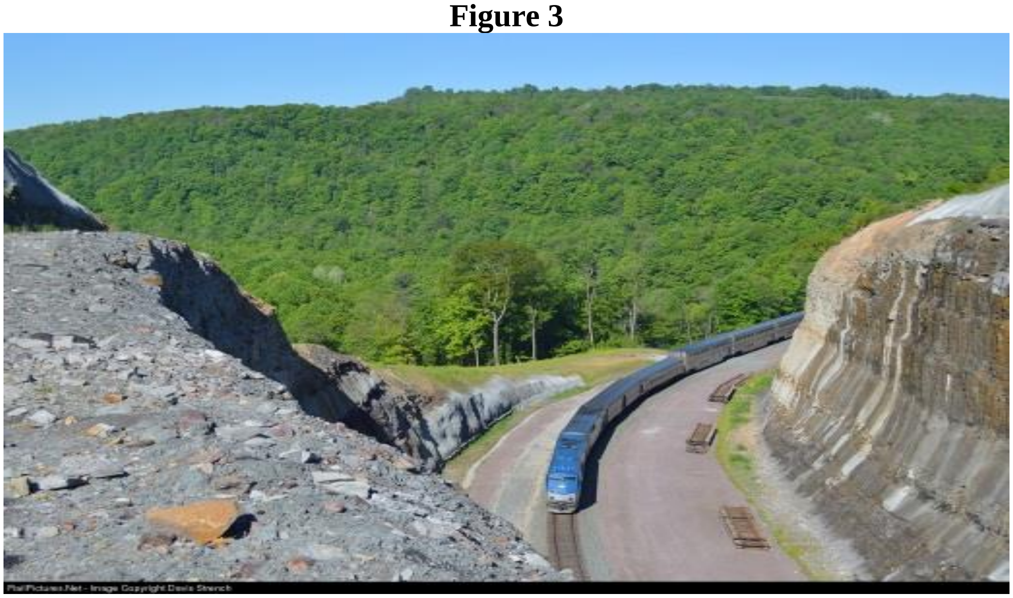
Figure 2

Figure 3



9. Bridges are constructed in areas where the topography drops away or is below the surrounding railroad right-of-way terrain. *See* Figures 4, 5. There are three basic types of railroad bridge construction, they are:
    - Rolled or welded beams for spans of 50 feet or less;

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- Bolted or welded plate girders for spans of 50-100 feet (can be up to 150 feet); and
- Bolted or welded trusses commonly used for spans over 100 feet.

Figure 4

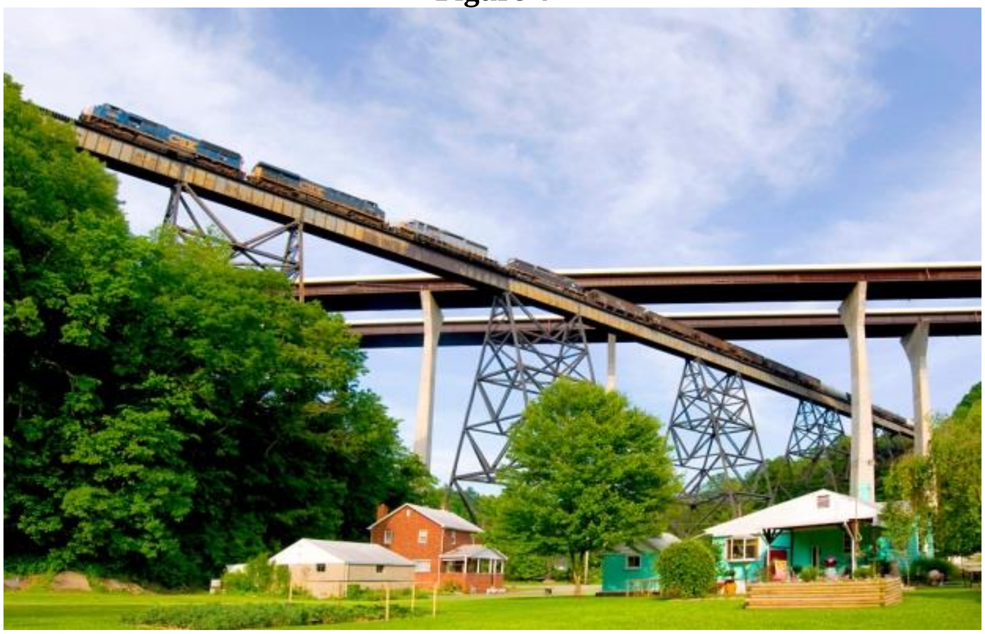
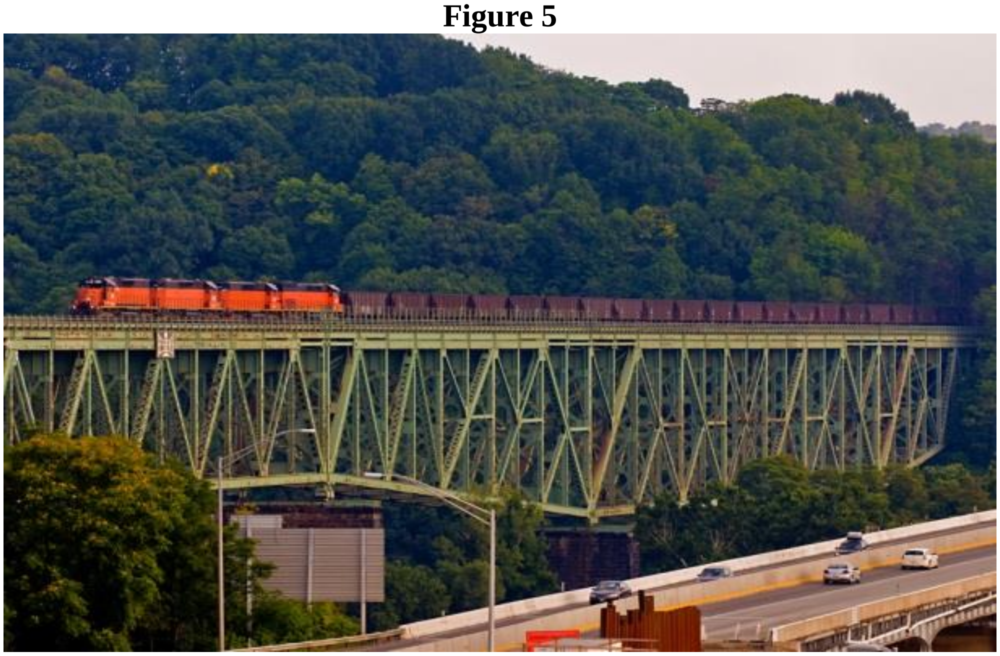


Figure 5



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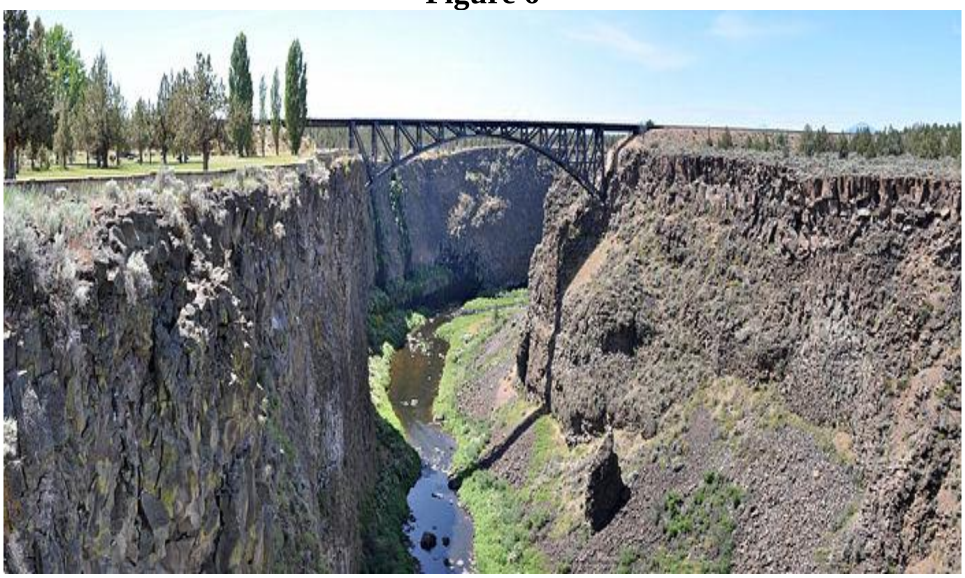
10. Depending on the type of terrain to be crossed, railroad bridges can be several feet, to hundreds of feet above the surface of ground or waterway beneath them. Through truss bridges are the most common type found on railroads. The Crooked River Railroad Bridge, part of a BNSF Railway line between the Columbia River and Bend, Oregon, crosses Oregon's Crooked River Canyon in southern Jefferson County at a height of 320 feet above the surface of the river and river bed. *See* Figure 6.

Figure 6



11. Bridges are constructed using pilings and abutments for anchoring and structural support. The AREMA standards use a formula to determine how deep pilings should be driven below the surface:

P = FWh/S+1

P = safe load in pounds
F = 2 for piles driven to practical refusal in any material
W = weight of hammer or ram in pounds
h = fall of hammer or stroke of piston in feet
S = average penetration in inches per blow, for the last 5 blows of a drop hammer or 20 blows of a single or double-acting hammer

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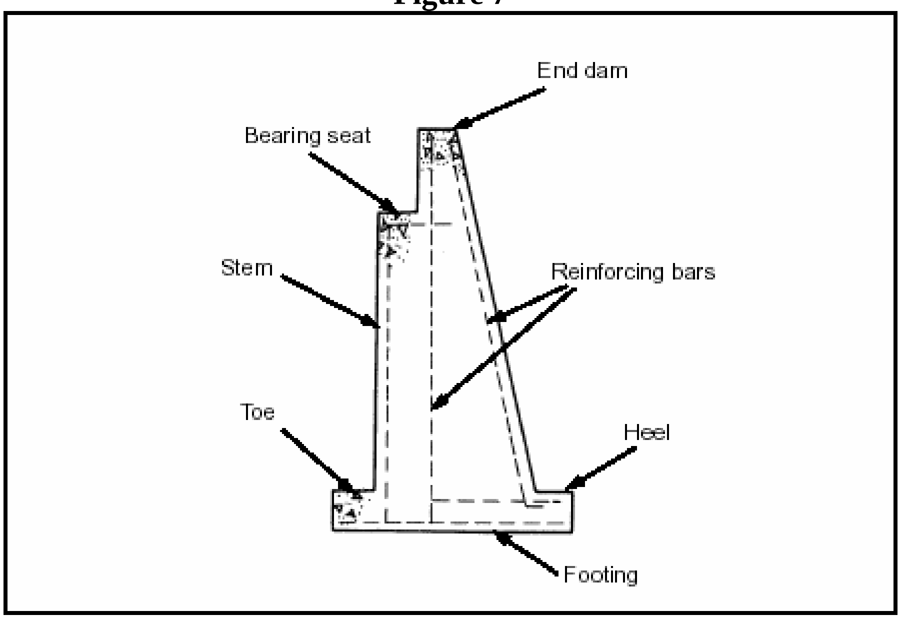
12. The above formula will determine the size, number, and depth for pilings used in bridge construction but, in general terms, the determining factors are size and weight of the bridge, the load bearing capacity of the bridge, the soil composition pilings are being driven into, and climate. For example, in areas of glacial till common to the Puget Sound area, the depth of pilings and other support structure are commonly 75' to 100' underground but, can be up to 260'deep like those on new bridges across the Columbia River.

13. For bridge abutments, AREMA requires a minimum standard for the base of the abutment; to be located below frost line, and without exception, no less than 3 ft. below the surface of the ground on the front edge or toe. *See* Figure 7.

Figure 7



14. Similar to pilings, the size of a railroad bridge abutment and its depth below surface of the railroad will depend on the size and weight of the bridge, the load bearing capacity of

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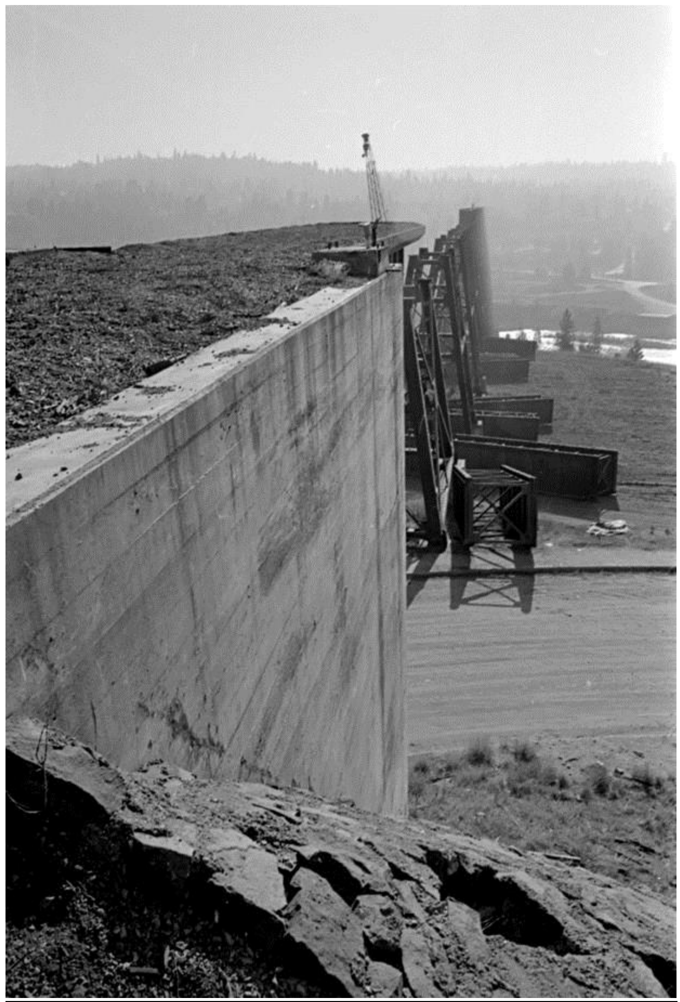
the bridge, the soil composition surrounding the abutment, climate, and the type of material used to create the abutment. For example, I am aware of abutments in Washington that extend to over 100' below the surface of the railroad. *See* Figure 8, illustrating an abutment in Spokane, Washington.

Figure 8



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Operating Clearance

15. In today's modern environment, sufficient clearances must be maintained in order to safely and efficiently operate trains over railroad lines. Clearances are designed to ensure that all types of railroad equipment can be operated in the safest possible manner. These clearance not only extend laterally, or side-to-side but, also vertically. Clearances, like other railroad engineering standards, are universally applied to all U.S. railroads and are also maintained - published by AREMA. The minimum vertical standards are measured from the top of the rail. Rail and tie plates, the devices that secure the rail to top of the ties, rests at a height of 8" above the ballast, or surface of the railroad. The minimum clearance above the top of the rail is 23', a height sufficient to allow a double stacked container car to move along the railroad unobstructed. Minimum clearance applying to overhead easements for road – highway overpasses and utilities (cable and pipe) is 25'.

Structures

16. Railroads also install structures above the right-of-way that are necessary for the safe and efficient movement of trains. Signal bridges, used to control multiple trains on the same section of railroad, are typically constructed directly over the track and can rise to 40'or more above the top of the rail. *See* Figure 9. With regard to bridges, the supporting steel and superstructure on through truss bridges can reach a height of more than 100' above the surface of the railroad. *See* Figure 10. Likewise, communications towers can rise to heights above 100'.

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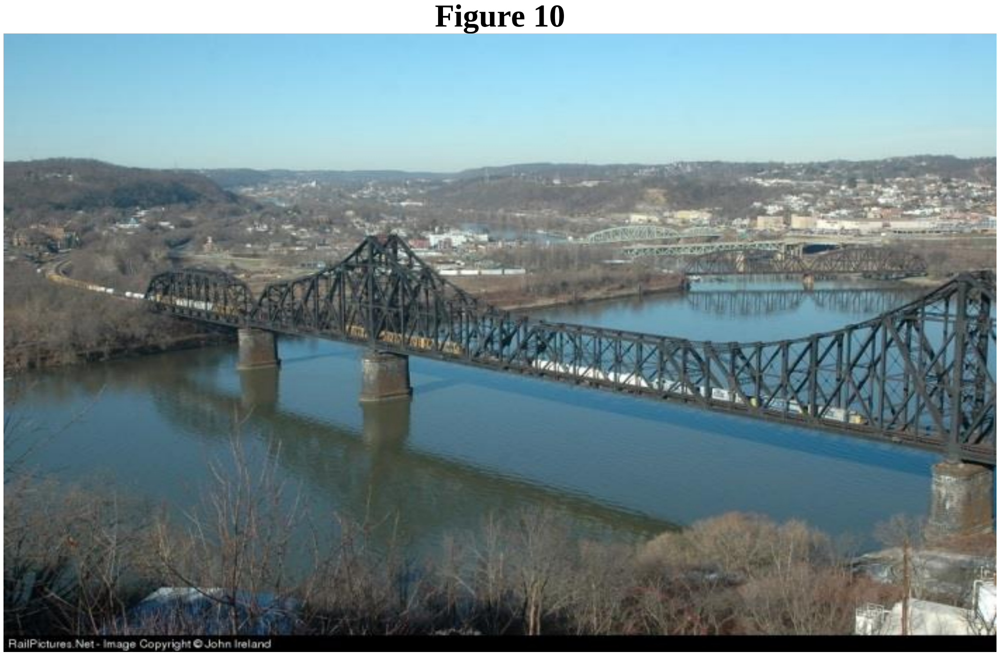
Figure 9

Figure 10



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Signed under penalty of perjury under the laws of Washington on this 11th day of September, 2015, at Arlington, Virginia.

Stephen M. Sullivan

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CERTIFICATE OF SERVICE

I hereby certify that on September 14, 2015, I electronically filed the foregoing with the Clerk of the Court using the CM/ECF system which will send notification of such filing to the following:

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DATED this 14th day of September, 2015.

s/Susie Clifford

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